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# Coir Pith for Eco-Development

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Due to poor or non-utilization of coir pith all round the world, its accumulation in the cocount producing countries since the last century has created ecological imbalance and thus has been designated as an unwanted waste. The huge generation of coir pith over the years, therefore, has caused serious problems like shortage of space pollution of land, water and air, loss of soil fertility due to percolation of lignin in the soil, deforestation, soil erosion, etc. In the present paper, the physical and chemical properties of coir pith carried out by laboratories of Auburn and Arkansas Universities at United States laboratory have been presented. The recent reported use of coir pith in conjunction with coir in the field of horiticulture, agriculture as coil brick, coir block and agro manure have been discussed. Many more specific applications with innovative designs of above materials in erosion control, vine hops, geo-textile, packaging, chemical industry and as rolls, matting and twines, fire resistant fabrices, portable readymade lawns, etc., have paved the way for the large-scale utilization of coir and coir pith for revenue generation commodities. The results of investigations carried out for the characterization of coir pith and process for the extraction and purification of lignin from coir pith is expected to enhance the utilization and industrial applications of coir pith have also been presented.

**Key Words: Coir pith, Eco-development.**

## INTRODUCTION

The long fibres of coir are extracted from the cocount husk and utilized in the manufacture of brushes, automobile seat and mattress stuffing, drainage pipe filters, twine and other products. Traditionally, the short fibres (2 mm or less) and dust (pith) left behind accumulate as a waste product for which a few industrial uses have been discovered. It is also called concopeat (this word has now been registered as a trademark by one of the manufacturers). Coir pith also known as coir dust is the spongy, peat like residue from the processing of coconut husks (mesocarp) for coir fibre. It consists of short fibres (< 2 cm) around 2–13% of the total and cork like particles ranging in size from granules to fine dust. Coir pith being a waste disposed from the coir industries pose the danger of pollution and health hazard. It is

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accumulated in large piles or 'dumps' outside the miils, which process the husks for extraction of the industrially valuable long fibres. The high lignin and cellulose content of the pith prevents the piles from breaking down further. Some of the piles in Sri Lanka and India are reportedly a century old. It is the composition that prevents its oxidation and resultant shrinkage of coir dust when it is used as a growing medium.

Coir pith strongly absorbs liquids and gases. This property is partly due to the honeycomb like structure of the mesocarp tissue, which gives it a high surface area per unit volume. Coir dust is also hydrophilic (attracts water) which means that moisture spreads readily over these surfaces. The extensive film of water that is produced gives moist coir the capacity to absorb air and other gases (odours). When first produced, coir dust is of light tan colour but darkens with age to chocolate brown.

The first stock-pile of coir dump appeared in Australia in the early part of twentieth century and the supplies were mostly dark. This was because the largest stockpiles were the first to be exploited and these were the oldest. Some of these coir dumps were reportedly over 100 years old. Now that this old material is becoming scarce in the country, more and more freshly processed coir is appearing in the market.

**Production of coir pith**

After the husk has been separated from the inner hard-shelled coconut, it is soaked in water to soften the pith and loosen the fibres. It is achieved by floating the husks in a lagoon for usually several months. The moist husk is then held against a revolving drum studded with metal spikes that comb the fibres out. During this operation, the long fibres are separated from the pith, which accumulates with the unwanted short fibres beneath the machine. This waste (coir pith) is removed to a nearby dump where it accumulates in large heaps.

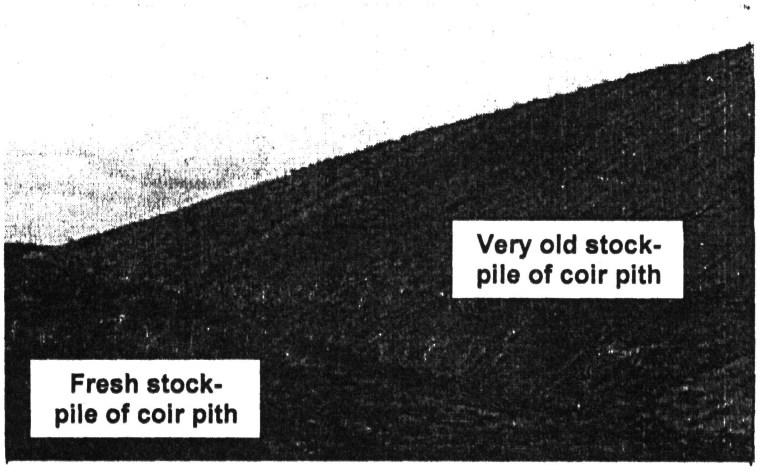


Fig. 1. Heaps of fresh and very old stockpiles of coir pith

However, for horticultural grade coir an additional process of screening is carried out. This is done to remove foreign objects and to give some consistency in particle size and fibre content. Coir dust is normally air dried and compressed into blocks or bails before it is exported to reduce transport costs. Before it can be used, the bale must be broken up.

For small quantities, the bale can simply be placed in a tub of water, which causes the coir dust to expand and the bale to crumble. With larger quantities, the bales are broken up in a mill. The latter method has the advantage of being able to handle dry material, which is both lighter and less bulky to transport than wet coir. Compressed coir increases in volume by 3–4 fold on breakout. A standard bale generally yields around 340 L of moist coir or approximately one third of an $m^3$.

The waste coir fibre (coir dust) was, until recently, the only part of the coconut tree that had no real value. Even the roots have a use as they release a potent narcotic when chewed. Coir pith is a poor fuel because it tends to smoulder and give off more smoke than heat. Fig. 1 shows two separate heaps of very old and the recent accumulation of coir pith.

**Physical and chemical properties of coir pith**

One of the most remarkable attributes of coir pith is its ease of wetting. Unlike peat, which becomes increasingly difficult to rewet as it dries down (said to be hydrophobic), coir pith remains relatively hydrophilic (water attracting) even when it is air dry. This property has great impact on the use and efficiency of water and fertilizer on the plant quality. Coir dust is very similar to peat in appearance. It is light to dark brown in colour and consists primarily of particles in the size range 0.2–2.0 mm (75–90%). Unlike sphagnum peat, there are no sticks of other extraneous matter. Independent analyses of coir pith were performed at Auburn University, University of Arkansas, and A & L Analytical Laboratories (Memphis, TN). The physical and chemical properties of coir pith are summarized in Tables 1 and 2[1].

Cresswell[2] looked at coir dust in comparison to sedge and sphagnum peat products and concluded that it has superior structural stability, water absorption ability and drainage, and cation exchange capacity compared to either sphagnum peat or sedge peat.

As seen from Table-2, coir dust tends to be high in both sodium and potassium and compared to the other peats, but sodium is leached readily from the material under irrigation[3]. The high levels of potassium present in coir dust are interesting to note and may actually prove more a benefit than any determent to plant growth. Coir dust from sources other than Sri Lanka also reportedly contained chlorides at levels toxic to many plants. Thus, it is very important that salinity in the raw material be monitored before processing into horticultural applications. It is evident that the chemical properties of this material can vary widely from source to source[4].

TABLE-1
PHYSICAL PROPERTIES OF COIR PITH

| Source | Properties | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | pH | % WHC[y] | % TPS[y] | % AS[y] | CEC | eC[x] | % TOM | % OC | C : N | % Lig | % Cel |
| | | | | | | | ** | ** | ** | ** | ** |
| 1. | 4.97 | ** | ** | ** | ** | 1.30 | ** | ** | ** | ** | ** |
| | 4.98 | | | | | 1.30 | ** | ** | ** | ** | ** |
| | 4.9 | 64.5 | 79.8 | 15.3 | 83.7[v] | 0.87 | ** | ** | ** | ** | ** |
| | 5.0 | 66.1 | 81.7 | 15.6 | 85.4[y] | 1.43 | ** | ** | ** | ** | ** |
| | 4.8 | ** | ** | ** | ** | 1.80 | ** | ** | ** | ** | ** |
| 2. | 5.4–6.8 | 8–9 times dry wt. | 94–96 | 10–12 | 60–130[y] | 2.5 max | 94–98 | 45–50 | 80.1 | 65–70 | 25–30 |
| 3. | 5.5 | ** | ** | ** | 21[u] | 0.8 | ** | ** | ** | ** | ** |
| | 5.7 | | | | 30[u] | 1.9 | ** | ** | ** | ** | ** |

% WHC = % water holding capacity, % TPS = total porosity, % As = air space, CEC = cation exchange capacity, eC = conductivity, % TOM = % total organic matter (w/w, dry basis), % OC = % organic carbon (w/w, dry basis), C : N = carbon nitrogen ratio, % Lig = % lignin, % Cel = % cellulose. (** values not reported)

[u]meq/L, [v]meq/100 g, dry basis, [x]dS/s, [y] column height unreported.

[w]1 = Auburn University Soil Testing Laboratory, 7 Jun 91; 2 = A & L Laboratories (Memphis, TN), 19 Jun 91; 3 = University of Arkansas Soil Testing Laboratory, 1 May 92; 4 = EZ Soil Co. data; 5 = Handreck (1993). All data except Handreck (1993) based on Ligocell coir dust.

TABLE-2
CHEMICAL PROPERTIES OF COIR PITH

| Source[x] | Elements | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N ($NO_3$) | N ($NH_4$) | P | K | Ca | Mg | S | Mn | Fe | B | Zn | Cu | $Cl^-$ | Na | Al |
| 1 | 2.22 | ** | 10 | 308 | 3 | 4 | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| | 2.46 | ** | 10 | 290 | 2 | 4 | ** | ** | ** | ** | ** | ** | ** | ** | ** |
| 2 | 2 | 2 | 8 | 172 | 4 | 3 | 33 | 0.1 | 0.5 | 1.0 | 0.07 | 0.03 | ** | 61 | <1 |
| | 1 | 2 | 6 | 271 | 2 | 4 | 10 | 0.1 | 0.4 | 0.1 | 0.11 | 0.04 | ** | 104 | <1 |
| 3 | 10.4 | ** | 8.5 | 319 | 3.9 | 4.6 | ** | ** | 0.9 | ** | 0.3 | 0.1 | ** | 105 | ** |
| 4 | 0 | 0 | 18 | 720 | 15 | 28 | 8 | 1.5 | 5 | 0.18 | 0.3 | 0.22 | 886 | 110 | ** |
| | 9 | 0 | 8 | 304 | 6 | 8 | 2 | 1.1 | 7 | 0.12 | 1.3 | 0.17 | 250 | 114 | ** |
| | | | | | | | | | | | 0.7 | | | | ** |

[z]1 = Auburn University Soil Testing Labotratory, 7 Jun 91; 2 = A & L Laboratories (Memphis, TN), 19 Jun 91; 3 = University of Arkansas Soil Tesing Laboratory, 1 May 92; 4 = Handreck (1993). All data except Handreck (1993) based on Lignocell coir dust. DPTA extraction of saturated media extract, ppm,

** Values not reported

The higher pH of coir dust may allow less lime to be added to a coir dust-basd medium, though adding dolomite to container soils is more important for Ca and Mg nutrition than for elevating pH. Cresswell[2] did find that a small amount of nitrogen drawdown (N kept from availability to plants during decomposition of organic amendments low in nitrogen) occurred with coir dust, but typical production fertilization practices would likely compensate for the small amount of resulting N loss. At present, it is still unclear as to how the fertilization regimes may need to be adjusted, if at all, in media composed chiefly of coir dust.

**Uses of coir dust**

Coir dust is used as a substitute for peat in a growing range of applications. The local supermarket shelves show that coir dust is now commonly used in retail potting mixes especially those that claim to be water efficient. An indication of its market acceptance is the prominence, now given on the bag to the words "Contains coir dust". This product is no longer the poor cousin of European peat.

The successful substitution of coir for peat in potting mixes has led to other uses. Coir dust is used as a medium for hydroponic production of flowers and vegetables replacing materials like rockwool, perlite and sawdust. Coir dust is also now used in soil mixes for golf courses. Coir dust has been tried as a casing layer in mushroom production and as a biological filter for odour control. The coir pith hitherto considered as a problematic waste is proving to be a source of wealth from waste. The potential of these non-traditional products is now well established but they are yet to gain their due recognition. Once they achieve their rightful place it would lead to a higher utilization of the coconut husk, which at present is only about 35% of its available quantity. This in turn would lead to creation of more employment opportunities, particularly in the rural areas. Use of these non-conventional coir products is an alternative strategy to the present day unsustainable exploitation of precious natural resources.

A comparatively new entrant in the non-conventional product range is coir pith, which is a spongy material that binds the coconut fibre in the husk. It is a by-product separated out of the husk while extracing the fibre. Its capacity to hold moisture eight times its weight makes coir pith an excellent soil conditioner. With the ban on mining of peat that is actually baby coal, the horiticulture industry was in search of an alternative material from a renewable resource. It was then that the coir pith was found to be a suitable substitute for natural peat. Raw pith, especially more than two years old is being widely used in the market of garden sector and commerical nurseries, mainly for hydroponic form of cultivation. The export demand for clean raw pith, devoid of any foreign bodies and with appropriate phyto-sanitary certification, is on the increase. The pith can also be composed into organic manure with the help of a fungus, *viz.*, *Plurotus sajor kaju.* This technology is now avaialble with the Coir Board of India for commercial exploitation. Arid and semi-arid land in our own country can be converted into arable land using coir pith. But it seems, our agricultural freaternity has not taken due note of this fact so far.

**Composted coir pith : An organic and eco-friendly product**

The coir pith is dumped in well laid out compost pits and treated with inoculum and wetted at specific intervals. The incubation period extends up to six months and after this period the pith is converted to enriched compost (devoid of lignin). At this stage the produce becomes absolutely odourless and is ready for agricultural uses. The composted coir pith is compressed into a brick sized light material. In order to use this brick in agriculture it is immersed in water (8–10 times the volume of the brick) taken in a container, which enlarges to 10 litres capacity and looks fluffy. This material has several uses in agriculture.

It has found extensive use in home gardens, in polybag nurseries, in greenhouse and commercial vegetable nurseries, in wasteland development and general uses in agriculture.

**Utility products from coir and coir pith**

Coir (coconut fibre) usage has become very common among professionals in various industries due to its versatility. In the horticultural industry, agricultural industry or erosion control industry, coir has established a remarkable reputation for its superiority to other available natural materials.

**Coir in horticulture industry**

Few well-designed tests have appeared assessing the performance of coir dust as a plant growth medium. Few technical reports, and the much larger anecdotal literature, are encouraging. Cresswell[2] compared coir dust to both sphagnum and sedge peat as a growing medium for broccoli, tomato and lettuce seedlings. He found earlier germination and greater size and uniformity of seedlings germinated and grown in coir dust. Handreck[3] tested growth of *Petunia* × *hybrida* 'Celebrity Salmon' in 5.6 : 1 (v : v) mixes of Malaysian coir dust, Sri Lankan coir dust or a sphagnum from Sakhalin, Russia and silica sand. He observed equal growth when all three mixes were adjusted to pH 6 and total plant nutrients were supplied, but varying performance with changes in nutrient regime. He concluded that plants in coir dust-based media require more Ca, S, Cu and Fe, but less K, than those grown in peat. He also observed greater immobilization of soluble nitrogen with coir dust than peat, an observation confirmed by Cresswell[4].

**Coir in agro-floriculture**

A spongy material that binds the coconut fibre in the husk, coir pith, is finding new applications. It is an excellent soil conditioner and is being extensively used as a soil-less medium for agri-horticultural purposes. With its moisture retention qualities, coir pith is ideal for growing anthuriums and orchids. A few of the coir pith products, *viz.*, coir pith block, coir pith brick and coir pith agro manure available from Phoenix as Lignocell[5] are shown here. Table-3 shows the physical and chemical properties of processed coir pith marketed by one of the manufacturers for use in horticulture.

Fig. 2a. Coir pith block manure

Fig. 2b. Coir pith brick

Fig. 2c. Coir pith agro

TABLE-3
PHYSICAL AND CHEMICAL PROPERTIES OF
PROCESSED COIR PITH FOR USE IN HORTICULTURE

| S. No. | Physical properties | Chemical properties |
|---|---|---|
| 1. | Good water retention. | 100% organic. |
| 2. | Increased aeration. | Holds water 7–8 times its weight and prevents desiccation of plants during heat. |
| 3. | Quick wetability. | Contains natural rooting hormones. |
| 4. | A solid potting medium and substratum for plants. | A pH of 5.2 to 6.8 is ideal for plant growth. |
| 5. | Increased air porosity pockets, which help the crops to root easily and profusely. | EC not more than 500 (μs/cm). |
| 6. | Coir has a high lignin to cellulose ratio compared to peat and therefore it is more resistant to physical breakdown. | Lignin content varies from 65–70% and new and excellent lignin based useful chemicals including lignin can be extracted from coir pith. |

## Uses of coir pith blocks

**(i) As a potting mix:** Coir pith block can be used as potting medium. It can be mixed with required fertilizers and nutrients according to the type of plant to be grown. **(ii) For mushroom growers:** Coir pith blocks are being used by a lot of mushroom growers around the world for the large-scale production of edible mushrooms. **(iii) As a soil supplement:** Re-hydrated coir block mixed with soil improves water holding capacity and aeration. **(iv) For generating seeds:** Coir dust in starter containers speeds up germination and profuse rooting of the seedlings. **(v) For tissue cultured plant:** Wetted coir brick in polybag encourages initial growth phase of tissue cultured plants and grafted seedlings.

**Coir in erosion control industry:** Compared to the horticultural and agricultural industries, coir is relatively new to the erosion control industry and it may take some time for this industry to learn and understand about coir. Recognition of coir in the erosion control industry has come from the fact that it is in abundance, renewable natural resource with an extremely low decomposition rate and a high strength compared to other natural fibres. In traditional erosion control blanket applications, coir blankets are well known for superior perfor-

mance compared to other organic blankets. In most of these applications, long-term tensile strength in the blankets is not a critical design criterion. The rapid growth of environmentally concerned designers with their innovative bioengineering designs has increased coir use in the erosion control industry. These designs incorporate coir products as structural components in the construction. This design was selected for the Environmental Excellence Design Award at the 1996 International Erosion Control Association (IECA) annual meeting. This award winning design expects the woven coir blanket to retain considerable tensile strength until the establishment of well-grown vegetation[6].

Fig. 3 is another bioengineering design using coir rolls with high strength brown bristle coir outer netting for river bank stabilization, an innovative fabric-encapsulated technique. This design requires the outer netting in coir rolls to retain strength for several years. Therefore, high strength retention or slow rate degradation of coir products in field applications fulfills the design expectations in these types of bioengineering designs[6].

Fig. 3. An innovative coir fabric encapsulated river-bank stabilization technique

**Coir in the agricultural industry:** For well over twenty years, hop growers in the agricultural industry have used coir twine to train hop vines. Hop growing season starts in Apirl and harvesting is done in mid-August to September. Young hop plants climb and grow on the 20 feet long coir twine. When hop vines reach their maturity, the vines are very heavy and the twines must be able to carry the weight in wet and windy conditions in hop growing areas. Years ago, hop growers went through the phase that erosion control industry professionals are now going through, seeking answers to questions on strength retention and durability of coir in field applications. Coir twines made of different coir types were introduced to hop growers by different sources. Finally after years of experience with coir twines made of different coir types, hop growers determined that the only acceptable coir twine for the hop industry is the 80–90 lb initial strength brown

bristle coir (freshwater-cured) twine. This twine has proved that it can support hop vines throughout their growing season without any problem. During the period that hop growers used a variety of coir twines made of different coir types, including white coir, they paid a huge price as coir twines other than the traditional brown bristle coir twines failed to support mature hop vines[6].

**Cocolawn as new initiative:** A readymade lawn (Cocolawn™) made up of coir netting, coir needled felt, coir pith and composted coir pith on which grass saplings are planted has recently been developed at one of the Coir Research Institutes under Coir Board of India. NRDC of India awarded the above invention in the year 2002. This readymade lawn is portable and can be transported and planted instantly at any place without any difficulty.

**Coir as geo-textile and on packaging:** Coir has been traditionally used as yarn, rope and floor coverings like mats and matting. Apart from these now coir is finding new applications as eco-friendly substitutes. Technologies have been developed for manufacturing coir fibre composites to substitute wood and synthetics. Coir bhoovastra has been acknowledged as an effective long-term biodegradable geo-textile for several soil bioengineering applications.

Coir Board in collaboration with the Indian Institute of Packaging, Mumbai has developed alternative to conventional wood based packaging material for various applications. Crates made out of coir composite board, for equipments like circuit breakers, lids for fibre drums, and collapsible reusable containers replacing plywood are some of the very exciting products developed under this project. They are found to be superior in quality compared to plywood, MDF board, etc., and are cost effective. Tests and trials carried out with these products have been sucessful. It is a patented technology now available for commerical production[7].

**Chemicals from coir pith:** Lignin is a phenolic polymeric complex that attaches with cellulose and hemicellulose. Cellulose is a linear polymer of glucose (six carbon sugar) and hemicellulose is a branched polymer of xylose (five carbon sugar). Extraction of these components from lignocellulosic materials, with minimal waste by-products and with environmentally friendly process, has to be taken into consideration in order to make it economically viable and acceptable. Sodium lignosulphate, a very useful compound, is extensively used in drilling of oil wells to reduce the viscosity of mud to cut down the power requirements. The potential of coir pith in absorbing N-waste is under study[8]. There is a big demand of coir and coir pith products in the world. As against the total export volume of 86,000 ton of coir products, the pith exports account for 20,000 tons.

**R&D work on coir pith at CVRCE:** The R&D wing and the Department of chemistry at CV Raman College of Engineering (CVRCE), Bhubaneswar are actively engaged in the analysis and utilization of coir pith. Although Orissa is 4th among coconut producing states in the country, however, there are no major coir processing industries in the state. In order to boost the coir processing industries, the fresh samples of coir pith collected from Coir India, Sakhigopal, in the district of Puri were analyzed in the laboratory for the physical and chemical properties of coir pith. The characterization of coir pith for different particle size distributions has been carried out as per the APHA Standard 1985. The chloride

content was estimated by titration of 100 mL of coir-water extract with standard silver nitrate solution using $K_2CrO_4$ indicator[9].

TABLE-4
CHARACTERIZATION OF COCONUT COIR PITH FROM SAKHIGOPAL, ORISSA

| S. No. | Parameter | Size distribution (mm) | | | |
|---|---|---|---|---|---|
| | | < 0.3 | 0.3–1.0 | 1.0–3.0 | 3.0–5.0 |
| 1. | pH (Fresh sample) | 10.050 | 10.05 | 10.050 | 10.050 |
| 2. | pH (Dry sample) | 4.800 | 4.80 | 4.800 | 4.800 |
| 3. | Chloride, ppm | 63.000 | 63.000 | 63.00 | 63.00 |
| 4. | Density, g/cm$^3$ | 1.019 | 1.019 | 1.019 | 1.019 |
| 5. | Moisture content, % | 15.600 | 16.200 | 16.300 | 16.800 |
| 6. | Volatile matter, % | 2.708 | 2.527 | 2.434 | 2.329 |
| 7. | Fixed carbon, % | 27.138 | 30.066 | 30.252 | 30.275 |
| 8. | Loss on ignition, % | 29.992 | 29.148 | 29.292 | 28.878 |
| 9. | Ash content, % | 5.222 | 4.864 | 4.692 | 3.694 |
| 10. | Silica, % | 6.060 | 6.878 | 6.648 | 6.708 |
| 11. | Other oxides, % | 1.216 | 1.119 | 1.064 | 0.929 |
| 12. | Lignin, % | 46.640 | 46.640 | 46.640 | 46.640 |
| 13. | Water holding capacity, % | 941.140 | 997.240 | 1008.830 | 1037.830 |
| 14. | Water absorption capacity, % | 68.30 | 63.60 | 66.30 | 66.0 |
| 15. | Water re-absorption capacity lignin, % | 2.15 | 3.78 | 5.08 | 5.95 |

**Extraction and purification of lignin**

Take 100 g of oven dry (OD) 100-mesh coir pith fines and add 2 L of water and presoak it overnight. To the presoaked coir pith add 52 mL of 20% NaOH solution. Cook the mixture in a pressure cooker (at 1 atm) for 5 h. Cool and filter to precipitate the black liquor. To the black filtrate that contains lignin add conc. HCl to completely precipitate lignin at pH 2.5–3.0. Filter and wash the precipitate with 72% $H_2SO_4$ and allow it to stand for 2 h. Add excess water to bring down the acid concentration to 3% and wash the filtrate to check the absence of $H_2SO_4$ by adding 1% $BaSO_4$ for any white precipitate.

For purification of the lignin, first of all, ether extraction is carried out in a Suxhlet apparatus for 5 h at 40°C. Ether is allowed to be evaporated from the sample. The dried sample is then treated with ethanol : benzene mixture (1 : 2) at 80°C till no colour appears in the solvent. The ether extracts fat and fatty acids from impure lignin whereas ethanol : benzene extraction removes the dyes and colouring materials from lignin. Dried to solid at 105°C for constant weight. The lignin is characterized by UV spectrophotometer and compared with standard

signature of lignin available in literature for its purity[10]. The lignin content in the coir pith is found to be 46.64%. A sample of extracted and purified lignin from coir pith is shown in Fig. 4. Lignin is a complex organic compound and and has many industrial applications in the chemical industries and a few of them are listed in Table-5. Further R&D work in this field on large-scale utilisation of coir pith for industrial and other applications is under investigation in the college.

TABLE-5
INDUSTRIAL APPLICATIONS OF LIGNIN

| S. N. | Fields | Applications |
|---|---|---|
| 1. | Additives | Oil well drilling muds, cements and concrete. Aerating agents in cements. |
| 2. | Dispersants | Thinners, pastes and slurries in water in the manufacture of:<br>(a) Porcelain tiles, cosmetics<br>(b) Paper coatings, tooth powder<br>(c) Gypsum boards, dyestuff<br>(d) Pesticides, Boiler tube additives<br>(e) Dispersion of carbon black<br>(f) Detergents and soap extenders |
| 3. | Ore floatation, emulsifiers, stabilisers | Oil in water emulsions, bitumen emulsions and asphalt emulsions |
| 4. | Grinding aids | Portland cement and ceramics |
| 5. | Binders and adhesives | Road construction, pellet making and briquetting. |
| 6. | Microbiology applications | Protein precipitants, sequestering agents for Ca, Ni, Sn, Zn, Al, Fe and Cu, etc. |
| 7. | Flame retardants | Phosphor esters. |
| 8. | Medical applications | Antibacterial activity for binding of carcinogens. |

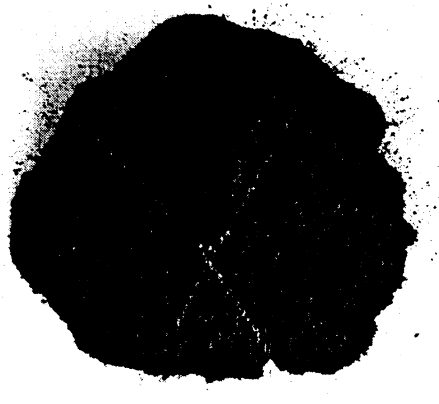

Fig. 4. A sample of extracted and purified lignin from coir pith

## Conclusions

The accumulation of coir pith in large heaps in most of the coconut producing countries since long, is the result of its non-utilization. While the fresh coir pith is brown in colour, the old stock of coir pith turns black. The time has come when coir pith or dust may well be a product of multiutility. The use of coir pith for making coir brick, block and agro manure have shown ways to the increased utilization of coir pith in future. The widespread use of this material in horiticulture, agriculture, geo-textile for control of fire hazards, soil erosion control, lawn and garden development have been discussed and presented. Although Orissa ranks 4th in coconut production, there are not many industries utilizing coir pith. The characterization of coir pith collected from one of the local industries has been carried out and presented. Lignin being one of the major constituents, the procedure for the extraction and purification of lignin from coir pith has been described in details. The use of lignin in various chemical and other industries will certainly lead to its large-scale utilization in future.

The availability of coir pith and coir at reasonable prices with consistent quality is now welcomed in India for converting this waste into wealth. The enormous demand of coir and coir pith products is a boon for local manufacturers in India. Development of products using coir and its by-products having industrial and consumer applications for export promotion and home consumption will not only lead to foreign exchange earning and enhance the national GDP but also reduce space requirment otherwise required for dumping or storage of these waste products. This will also minimize the enviromental pollution in turn creating eco-friendly atmosphere around the coir industries in the country.

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